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CHEMICAL STRUCTURE OF CYTOPLASM

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IN a recent note written as a supplement to a symposium on the structure of protoplasm, K. H. Meyer[1] summarizes Seifriz's view of the structure of protoplasm as follows: "the ultimate structural units of the living substance are probably linear molecules or micellae so arranged as to form a framework" and "the living substance is composed of a true network of primary valence chains which at several points are tied together by chemical bridges held by molecular cohesion (to-day one would say residual valences or hydrogen bonds)." If Meyer had substituted in the first statement the work "some" for "ultimate" and left out the framework which requires further definition, and in the second statement had substituted the word "contains" for "is composed of" this would be acceptable to the majority of students of cell structure. X-ray diffraction and birefringence studies have brought convincing support to the conception of structural constituents in protoplasm which Seifriz[2] with so much genius and foresight advanced a decade and a half ago.

This theory, however, interprets only some of the properties of protoplasm. These as listed by Seifriz[3] are: "contractility, elasticity, cohesiveness, rigidity, and tensile strength." All these may be possessed by non-living systems. Protoplasm on the contrary respires, excretes, performs complicated chemical operations, uses or liberates energy and reproduces its own substance in kind. This metabolism is mediated by a multitude of intracellular enzymes and carriers and

[1] K. H. Meyer, "The Structure of Protoplasm," Iowa State College, p. 267, 1942.

[2] W. Seifriz, *Brit. Jour. Exp. Biol.*, 1: 431, 1923–4.

[3] W. Seifriz, *Am. Nat.*, 63: 410, 1929.

can be imitated in part *in vitro* but in the cell is characterized by speed, orderliness and rhythm not to be found in a random mixture of chemical substances in solution.

This dilemma in the application of the concept of molecular pattern to the problem of protoplasmic structure has been fully appreciated by Sponsler,[4] Sponsler and Bath[5] and the late Laurence Moyer,[6] who examined the possibilities of the orderly attachment of enzymes, carriers, lipids, etc., to polypeptid chains by hydrogen bonds, von der Waal's forces and salt and sulfur bridges. Sponsler also recognized the presence of microscopic and submicroscopic particulates and discussed the formation of them by folding of polypeptid chains.

This is all very plausible, and useful, in so far as it is capable of experimental test or contributes to the discovery of new methods of investigation. It is a laudable effort to reduce the nature of living substance to a monistic formula.

Protoplasm, however, does not possess either microscopic or submicroscopic homogeneity. Even when it seems optically structureless it may conceal behind the mask of simplicity those local differences of organization which express themselves in determinate cleavage. Often protoplasm is composed of distinct, different and to some extent separable parts. This was demonstrated by Reinke and Rodewald[7] when they pressed out the liquid protoplasm of *Aethalium septicum* and so divided it into liquid and solid fractions, and by innumerable chemists since who have extracted cells with saline solutions and found that only part of them dissolved.

It would seem to be an axiom of analytic chemistry to separate separable things before proceeding to their analysis. The alternative method of mixing all the constituents of the cell as thoroughly as possible and then obtaining from the mixture substances in pure form by skilful chemical procedures has yielded brilliant results in the field of hormones, enzymes, nucleic acids, etc., but has left us in ignorance of the protein structural substrate of the cell and of the distribution and spatial relationships of the active substances.

The possibilities of the method of separating separable things first have been developed in this laboratory and more recently by Claude at the Rockefeller Institute in the separation and preliminary analysis of mitochondria and of several types of submicroscopic particulate components of protoplasm and in the isolation of the structural proteins from the difficultly soluble cytoplasmic components. It is my purpose to review briefly the progress which has been made in this field.

Structural Proteins

The difficultly soluble portions of cells have been much neglected by biochemists, presumably because they were impressed by the ease with which proteins may be denatured and by the fact that such insoluble residues of organs always contain connective tissues. I shared this point of view until Hoerr and I[8] began to work with frozen dried material prepared by the Altmann-Gersh method. This method afforded an opportunity, by the use of freehand sections, to introduce solvent solutions to the interior of a chemically unaltered cell without encountering the obstacle of semi-permeability. In such preparations of the liver of the guinea pig treated with 0.85 per cent. NaCl solution the mobile protein of the cell quickly dissolved but left behind a morphologically complete cell with mitochondria, nuclear chromatin, cell and nuclear membranes. Treatment with $\frac{N}{200}$ ammonia solution removed the mitochondria and nuclear chromatin but left behind a cell with membrane, cytoplasmic substrate, nuclear membrane and linin threads. This residue we termed structural protein. We were first unable to dissolve in it anything but strong alkali. From this solution it precipitated on neutralization in membranous floccules with fibers running through them. On repeated solution and precipitation the substance became more flocculent and less fibrous and evidently had undergone some hydrolysis. To this material we gave the name *ellipsin* in recognition of the long hiatus in our study of the cell during which structural considerations had been jettisoned by those who believed that the liquid state excluded them.

Mirsky[9] reported the portion of the eggs of Arbacia and Strongylocentrotus insoluble in M_1KCl solution to be increased after fertilization, and Moore and Miller[10] found that the eggs of Strongylocentrotus which were isotropic became anisotropic in three minutes after fertilization indicating an orientation of structural elements.

In 1938 I[11] reported that a portion of the washed hepatic cell was soluble in stronger salt solution (10 per cent. NaCl) yielding highly viscous solutions with pronounced elastic properties. Those solutions precipitated on dilution or acidification as discrete fibers of great length which tended to assemble side by side

[4] O. L. Sponsler, "The Cell and Protoplasm," p. 166, The Science Press, 1940.

[5] O. L. Sponsler and J. D. Bath, "The Structure of Protoplasm," p. 41, Iowa State College Press, 1942.

[6] L. S. Moyer, "The Structure of Protoplasm," p. 23, Iowa State College Press, 1942.

[7] J. Reinke and H. Rodewald, *Untersach. a. d. bot. Lat. der. Universitat,* pp. i–viii and 1–70, Göttingen, Heft 2, 1881.

[8] R. R. Bensley and N. L. Hoerr, *Anat. Rec.,* 60: 251, 1934.

[9] A. E. Mirsky, SCIENCE, 84: 333, 1936.

[10] A. R. Moore and W. A. Miller, *Proc. Soc. Exp. Biol. Med.,* 36: 835, 1937.

[11] R. R. Bensley, *Anat. Rec.,* 72: 351, 1938.

into fascicles. Soon after formation the mass of fibers contracted into a knot. To this substance I gave the name *plasmosin,* because of a fancied resemblance to myosin, reserving the name *ellipsin* for the residual substance not soluble in 10 per cent. NaCl.

In 1940 Banga and Szent-Györgyi[12] by extracting washed kidney tissue with a 30 per cent. solution of urea obtained a similar viscous extract which when precipitated in fibrous form gave an x-ray diagram similar to myosin B. The insoluble residue, insoluble either in saline solutions or 30 per cent. urea solution, when dissolved in alkaline solution exhibited streaming birefringence.

I am not sure that the fractions obtained by Banga and Szent-Györgyi are the same as those of Hoerr and the writer, because urea solutions are under suspicion by reason of their capacity of converting corpuscular proteins into fibrous proteins,[13] but the general trend of their work is the same and these distinguished chemists are not at all embarrassed by the possibility of denaturation.

My first preparations of plasmosin were highly contaminated by other substances since I found it difficult to purify by repeated solution and precipitation. Lazarow, my assistant, however, working in a cold room at + 2° C. and transferring the balloon of fibers to fresh solvent before it had contracted into a mass was able to redissolve and reprecipitate several times. Also we found that unless the water used in dilution was buffered to pH 6.8 with citrate or phosphate buffer much protein was adsorbed by the fibers.

The purified product contained 3.7 per cent. of phosphorus and gave positive pentose and purin base reactions. It was obviously a nucleoprotein. This fact would suggest to many minds its origin from the nucleus. The idea that nucleoproteins are confined to the nucleus has, however, been breaking down owing to the discovery that many active components of cells have a nucleotide structure and the discovery of Claude[14] that the particulates contain nucleoprotein. Casperson and Schulz[15] also have demonstrated the presence of nucleoprotein in cytoplasm by spectrophotometric methods. I would not wish to reject the idea that the nuclei contain plasmosin, but the rapid rise in viscosity of suspensions of washed cells in 10 per cent. NaCl solution compared with the slow rate of extraction of the nuclear chromatin in the same solution and the rapid extraction of plasmosin from frozen dried cells without much loss of nuclear chromatin inclines me to the opinion I previously expressed that it is in large measure a constituent of cytoplasm. Whether it originates there or is produced in the nucleus is of course an interesting topic for speculation and research.

Plasmosin in solution in 10 per cent. NaCl dialysed against distilled water lightly buffered to pH 6.9 with phosphate buffer first precipitates as fibers, then the precipitate swells into a gel, and finally redissolves as the electrolyte is progressively reduced. In this state it has an isoelectric point of about pH 3.2. Thus, plasmosin may be extracted from cells by strong solutions of NaCl at a level of pH at which most of the mobile proteins are insoluble. Plasmosin is also soluble in 30 per cent. urea solution.

The portion of the liver cell which remains after removal of mobile proteins, mitochondria, submicroscopic particulates, nuclear chromatin and plasmosin represents cell and nuclear membranes, substrate of cytoplasm and linin threads. It is completely soluble in $\frac{N}{2}$ sodium hydrate and is reprecipitated on neutralization. The preparation carries about 25 per cent. of its dry weight of lipids. The preparation is phosphorus free and thus my original suggestion that it was a denatured form of plasmosin can not be sustained. I have suggested that the name *ellipsin* be retained for this material, although it seems hardly possible that it represents a single substance.

It is obvious that plasmosin is the substance associated with the variable solation-gelation phenomena and possibly in an oriented state with spindle and aster formation, while ellipsin is concerned with the more stable structural substrate of the cell such as membrane and perhaps intracellular fibril formation. The fact that we have produced membranous sheets which included fibers and have a lipid content of about 25 per cent. of dry weight should add weight to Schmitt's[16] conception of alternating protein and bi-molecular phospholipid components in cell membranes.

The amount of these structural proteins in cells in spite of the impressive showing which they make under the microscope is small. As is well known the fibrous macromolecules are capable of producing high viscosity at low concentration.

Particulate Components of Protoplasm

The fact that certain of the particulate components of protoplasm have sufficient stability in ordinary saline solution to permit their isolation should have been apparent from Plosz's[17] (1872) experiments with which I had been familiar for many years, but I did not perceive this at first and had to learn it by the

[12] I. Banga and A. Szent-Györgyi, SCIENCE, 92: 514, 1940.

[13] W. T. Astbury, *Symposia on Quantitative Biology,* Cold Spring Harbor, 6: 120, 1938.

[14] A. Claude, SCIENCE, 91: 77, 1940.

[15] G. Casperson and J. Schulz, *Proc. Nat. Acad. Sci.,* 26: 507, 1940.

[16] F. O. Schmitt, *Physiol. Rev.,* 19: 270, 1939.

[17] P. Plosz, *Arch. f. d. ges. Physiol.,* 7: 371, 1873.

hard way of study of frozen dried material and fresh cells. Warburg[18] too had partially separated mitochondria in 1912 and noted their participation in the oxygen uptake of saline extracts of liver. However, Hoerr and I[19, 20] succeeded in 1934, 1937, in separating mitochondria from liver cells and making preliminary analyses. I had no suspicion at first that still smaller particulates were present in the liver cell until Lazarow, by long-continued centrifugation, obtained a glassy cherry red pellet composed of particles so minute that they were quite invisible under the microscope, but showed in the dark field of the cardioid condenser a shimmering field of light in which individual particles could with difficulty be distinguished. We were investigating this particle when Claude[14] announced his discovery of the presence of submicroscopic particulates in clarified saline extracts of embryo chick. Claude's particles contained nucleoprotein and phospholipid, the latter in part acetal phosphatid, which we were later able to confirm for mitochondria and the red pellet from liver. Claude thought that his particles were mitochondria which clearly could not be the case since mitochondria are not submicroscopic in size. The fundamental idea of kinship between these two components is, however, not to be so summarily rejected, since we know nothing of the antecedents or the products of either.

It is noteworthy that Claude[21] had previously found the virus of chick sarcoma associated with a similar particulate and that Stern and Wyckoff[22] recovered a pigmented pellet from liver extracts which had catalase activity.

In case any one should be inclined to regard mitochondria and the submicroscopic particulates as unimportant and casual products of cell metabolism or the result of temporary flocculation of cell constituents I would recommend that they suspend judgment until they learn of the lipid and enzyme content of these structures and their extraordinarily complex composition.

The analysis of particulate components of cytoplasm is only as good as the species-purity of the preparation and much effort has been expended on this phase of the work. It is quite certain that the original preparations of hepatic mitochondria which were separated at rather high speeds were contaminated with glycogen which is also particulate[23] and with the red submicroscopic particle and it is equally certain that the fractions obtained by Claude[24] by time fractionation at high speed were mixtures. The general trend of Claude's analyses of his fractions, however, accords well with our analyses of preparations made with much greater care, but the quantitative results are different.

Both mitochondria and submicroscopics have a high water content which, however, we have not been able to determine with accuracy owing to the unknown factor of dilatancy operating while the centrifuge is coming to rest. The results were for mitochondria 82.5 per cent., for submicroscopics 89.8 per cent., which for the reasons stated are probably too high.

Mitochondria and submicroscopic particulates are stable in 0.85 per cent. NaCl solutions but swell and lose substance if the electrolyte content is much reduced. They dissolve in water on the alkaline and on the acid side of their pH stability range. The latter has not been determined with accuracy but is known to be dependent also on electrolyte concentration. We have not been able to find that the stability is much influenced by the substitution of NaCl for the normal inorganic constituents of the cell water, but the enzymatic activities apparently are.

Qualitatively, mitochondria and submicroscopic particulates are similar in composition but there are quantitative differences.

The following substances have been identified chemically in both groups: protein, nucleoprotein, flavoprotein, triglycerides, lecithin, sterol and vitamin A, the latter by Goerner and Goerner.[25] The submicroscopics have a higher content of lipids, nucleoprotein, flavoprotein and water than mitochondria. The yellow color of mitochondria and the cherry red color of submicroscopic particles are due in part at least to flavoproteins. This has been confirmed by extraction of riboflavin and its conversion by the action of light in alkaline solution into chloroform-soluble lumiflavin.

The succinoxidase system has been demonstrated in both mitochondria and submicroscopics by Lazarow and Barrón.[26] Both give a moderate positive reaction for cytochrome oxidase with the nadi reagent, but the presence of Cytochrome C has not yet been confirmed by spectroscopic study. Both catalyse the decomposition of hydrogen peroxide.

Kabat[27] has demonstrated the greater concentration of phosphatase in a particulate from kidney separated from clarified suspensions at 27,000 RPM and has made interesting suggestions as to the function of particulates in the orderly assembling of members

[18] O. Warburg, *Arch. f. d. ges. Physiol.*, 54: 595, 1912.
[19] R. R. Bensley and N. L. Hoerr, *Anat. Rec.*, 60: 449, 1934.
[20] R. R. Bensley, *Anat. Rec.*, 69: 341, 1937.
[21] A. Claude, SCIENCE, 90: 213, 1939.
[22] K. G. Stern and R. W. G. Wyckoff, *Jour. Biol. Chem.*, 124: 573, 1938.
[23] A. Lazarow, SCIENCE, 95: 48, 1942.
[24] A. Claude, *Symposia on Quantitative Biology*, Cold Spring Harbor, 9: 263, 1941.
[25] A. Goerner and M. M. Goerner, *Jour. Biol. Chem.*, 123: 57, 1938; A. Goerner, *Jour. Biol. Chem.*, 122: 529, 1937–38.
[26] A. Lazarow and E. S. G. Barrón, *Anat. Rec.*, 79: 41, Suppl.
[27] E. A. Kabat, SCIENCE, 93: 44, 1940.

of enzyme carrier systems which recall earlier suggestions made on the same topic by Stern.[28]

The high lipid content of the mitochondria and particulates calls for some comment. Dry mitochondria contain about 34 per cent. of lipids; dry particulates as high as 51 per cent. Both figures are much higher than the average content of the whole cell. Therefore other portions of the cell contain much less than the average. Recent quantitative studies of this distribution reveal that structural proteins and particulates in the liver together carry about 90 per cent. of the total dispersed lipids and as high as 98 per cent. of the phospholipids. These determinations must be made on cells without an oil phase. Plasmosin contains when purified little fat, about 4 per cent., the ellipsin residue about 25 per cent. Thus, in the liver the interparticulate liquid contains little disperse fat and almost no phospholipid. These substances are largely contained in these little packets which I have called particulates and bound in the membranous and fibrous portion of the cell.

On the other hand, the interparticulate portion of the cytoplasm contains much protein, probably for the most part of the corpuscular or globular type. It also contains some flavoproteins but does not oxidize succinate, indicating that some essential member of the succinoxidase chain is missing. I do not know what the content of Wyckoff's macromolecular substances is or where they fit into this conception of protoplasm.

The fat distribution in mitochondria and in particulates does not differ in any important respect from that of the whole cell. Our previous estimates of lecithin were too low owing to the use of the unreliable acetone precipitation method. Phospholipid estimated as lecithin from phosphorus determinations show a content of lecithin of 45 to 58 per cent. of the total lipids. A positive Schiff reaction indicates a content of acetal phosphatid. The distribution as to lecithin kephalin and sphingomyelin has not been determined. We have not yet determined the inorganic constituents of the particulates.

Cytoplasm thus has no ultimate structural unit but consists instead of several perhaps many different types of units, all cooperating in an orderly fashion to produce that ensemble of properties which we call life. At the present time our knowledge is very incomplete but we can recognize the following categories:

(1) Those units upon which the integrity of the cell as a unit of structure, the maintenance of its organization, and those properties enumerated by Seifriz, depend. In these units the fibrous proteins and nucleoproteins with associated lipids, etc., described play an important role.

(2) Particulates, microscopic and submicroscopic, of highly complex composition mediating special chemical processes.

(3) The interparticulate liquid menstruum also of complex composition but at present little understood.

The methods and quantitative results upon which the foregoing statements are based will be published elsewhere in collaboration with Dr. Lazarow, who for several years has assisted me in the work.

Obviously the possibility of separating mitochondria and particulates and of isolating the structural proteins for chemical study opens up a rich field for further research. The localization of enzyme and carrier systems, vitamins and hormones, and the viruses, functional changes in composition, the tracing of radioactive isotopes into the interior of the cell and the further fractionation of the submicroscopic particles by more refined methods all offer inviting opportunities to the inquiring mind.

It is a pleasure to acknowledge that my work has been much helped by the loyal and generous attitude of my colleagues and former students in the Department of Anatomy and by the generous contribution of funds from the Rockefeller grant and from the Wallace C. and Clara A. Abbott Memorial Fund of the University of Chicago.

It is a pleasure also to reflect that the funds at my disposal have never been large enough to tempt me to abandon investigation for direction of others, and thus to miss in these years of retirement the joys that come, in fullest measure, only to those who satisfy their desire for knowledge by a direct and personal appeal to nature by research.

WARTIME MAINTENANCE OF SCIENTIFIC PRODUCTION

By Dr. J. S. NICHOLAS

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MANY theses have been founded on the relationship of supply and demand. When the President made his wartime demands on industry, few thought that the stated objectives could be attained. Although in some cases there has not been complete attainment, in the majority and dominant aspects of the program

[28] K. G. Stern, *Symposia on Quantitative Biology*, Cold Spring Harbor, 7: 312, 1939.

there has been generally an increase in production beyond all expectation—in some cases greatly exceeding the amount for which the President asked.

There are brightening aspects of production. With typical American spirit we have taken regard of the impossible and have proved it possible. Output has been speeded; the number of man-power hours necessary for each operation has been decreased. Technical details of model changes and modification have been met with a just perceptible ripple in the flow of output. Material supplies have literally been created either by substitution of more accessible products or the more efficient handling of old ones. In industry, both production and supply have worked miracles.

The academic production, however, has suffered by contrast with the industrial. The demands upon industry have been proportionately small compared with those presented to the academic circle. Industry was faced with an immediately crystallized objective and the operations incident to its realization could be clearly sketched and evaluated. Its needs were recognized and men were detailed either from other less essential plants or from our colleges to make these operations practicable. Conditions within the universities were not so simple, for various reasons.

In the first place, the armed services had for some time been able to develop little in the lines of research incident to the utilization of equipment of modern warfare. Present survey shows that the Army had plans for modernized combat units, but these were paper plans constructed in the main without the benefit of practice and observation necessary for the perfection of practical organized tactical combat units.

In order to utilize the new appliances which were to be employed against an enemy with years of practice in the field, there resulted immediately an exceedingly concentrated call upon academic resources for practical research strictly applied to the combat mechanics of new apparatus. This naturally necessitated short cuts of all types, and the staff and student body of our universities have contributed much toward the rapid organization and rapid advances along these lines.

The question of demand brought about a situation which our colleges and universities were more unprepared to face than had been the army with reference to mechanized warfare. Most academic staffs had been built up over a period of years with the idea of maximum teaching load and but a small proportion of time had been designated for research. However, a few more public-spirited institutions, which had been far-sighted enough to allot to research and development a larger share, were immediately available for the government's call and their staffs have formed the backbone of research in the transfer from the needs of peace to the necessities for war. This change of emphasis involved the total effort of some of our science departments, with, in some cases, a complete demolition of what had been a useful academic team.

The fact that we are participating in total war which demands total effort can not be overemphasized. The total effort of academic groups has so far been harnessed in only a desultory fashion. Research men have been called into the services or into governmental organizations without thought for the future. No replacements exist in some fields for the men who have been withdrawn to necessary and urgent work, either in industry, governmental research or armed services.

No advanced planning could have foreseen the extent of our academic involvement but now the time has come when the allocation of certain groups of personnel must be accomplished as ruthlessly as is the work of the local tire rationing boards. This is peculiarly so in highly specialized and trained groups in which we have a sharply limited supply. Some of these supplies have reached a level so low that replacement production is seriously impeded. In the academic field we have been muddling through so far by changing the working load, by accelerating schedules and eliminating vacation time. This would considerably increase output if we retained an adequate staff on the academic production line, but this it has been impossible to maintain.

The fields from which the greatest amount of research personnel has been removed for war effort are those which now have the greatest teaching load in production. Specifically, the shortages are greatest in physics and mathematics, which are focal points of emphasis in the new armed forces' program now rapidly becoming installed in our colleges and universities. The enrolments in these fields, particularly during the immediate future, will be far greater than even a full peacetime staff could handle, for many students in upper classes will, by the service regulation, be compelled to complete this training. Depletion of the staff by the part-time or full-time participation in other war activities must be recognized as a fact. We must produce substitutes in these fields just as energetically as we would produce a rubber substitute.

For the past eight months we have been robbing Peter to pay Paul in the academic world. Bidding for available men in a field has proceeded with alacrity as one institution has taken men from another in order to satisfy its needs. The original supplies have been exhausted, but there is a new source to be tapped; the problem now appears possible of solution, at least in part, by the appropriate transfer and

utilization of trained men from other fields. Geologists and economists can take over the teaching load in physics, chemistry or mathematics. Biologists and psychologists can take over other teaching duties in addition to those incident to their own important output, which must be maintained. It is possible that some teachers in history, classics, linguistics, anthropology and literature may also be fitted to teach in mathematics, particularly at elementary levels. The personnel of our schools and departments of education should be particularly applicable to such needs.

A teacher is a teacher, irrespective of the branch of learning. The methods and the students are the same—only the subject-matter is different. The university and college grade teacher can and must carry his personality and intellectual acumen into other fields of endeavor in addition to his own. This, while it may not be easy, is an immediate necessity. The standards and detail of subject-matter must be clearly presented to the substitute volunteers, and possibly refresher courses must be given by the specialists still remaining on the staff. This is one obvious source of man-power which can be utilized in the production of scientifically trained men.

A second source may be drawn upon from individuals who are in administration and have been removed from student problems for a long period of time. Many institutions are carrying a too large proportion of administrative officers, some of whom could be usefully reallocated at the universities' main job of production, teaching.

There is a third source as yet practically undeveloped and that is in the field of woman power in academic teaching. For many years women have been discouraged from attempting to enter academic fields. Now we need all of them that have been adequately trained and unfortunately that number is exceedingly limited, for when their placement has been made difficult for many years and their acceptance even by our leading female colleges has been rather tardy, all too few first-rate women scientists have been trained. To-day we could use ten times the numbers that are available if only the peace-time prejudices could be overcome.

From the above it is clear that there are many phases to the battle of scientific personnel production. One phase can not be overemphasized sufficiently, and rests with the personal conscience of many a teacher of science. It is easy to leave one's post and to accept new responsibilities, but are they always of greater utility than the accustomed routine or its possibility of rejuvenated potentiality? The importance of what you are now doing and how to intensify your effort must be evaluated by you individually. The home front is a pressing one which demands the best that we have if we are to keep our training program intact. We can not proceed on the simple substitute principle. A greater and more far-reaching view is demanded with a look toward a war future which is longer than any of us had ever anticipated. With this in mind let no one belittle his talents and opportunities on the home front of academic production. They are important, vital and of a degree of necessity which the country now demands. We will win the war—we must have trained thinking men to win and maintain the peace.

OBITUARY

ROSS AIKEN GORTNER
1885–1942

DEATH came Wednesday morning, September 30, to Ross Aiken Gortner, 57, chief of the Division of Biochemistry of the University of Minnesota, eminent scientist and scholar. Dr. Gortner had been able to carry on his work up to a few days before his passing, which resulted from a heart attack. He was first stricken with a heart ailment in the summer of 1938, and while the curtailment of his normal life of seemingly boundless energy was a sore trial to his spirit he made the adjustment with remarkable equanimity. Thus he was able to continue most of the scientific and social contacts to which he had been accustomed, and also carry the load of executive work of an expanding department as well as lecture to his classes, with few interruptions.

Dr. R. A. Gortner was born at O'Neill, Nebraska, on March 20, 1885. After graduation from Nebraska Wesleyan University in 1907 he earned his M.S. degree in 1908 from the University of Toronto, where he worked with the late Dr. W. Lash Miller, and his Ph.D. degree from Columbia University in 1909 under the direction of Dr. Marston T. Bogert. An honorary Sc.D. was conferred on him in 1932 by Lawrence College.

Dr. Gortner came to the University of Minnesota in 1914 as associate professor in the Division of Soils from the Station for Experimental Evolution at Cold Spring Harbor, N. Y. It was during the period at the Carnegie station that Dr. Gortner formed his close personal and scientific association with the late Dr. J. Arthur Harris, who probably exerted more influence on Dr. Gortner's scientific thinking than any other one person. This association culminated in Dr. Gortner being largely instrumental in bringing Dr. Harris to the University of Minnesota as head of the department of botany.

Dr. Gortner transferred to the Division of Biochemistry of the University of Minnesota in 1916 as associate professor and was made full professor and chief of that division in 1917, which position he held at his death.

Dr. Gortner's contributions to scientific journals number more than 300. His scientific interests were very broad. This became evident very early in his career. His first interests were chiefly in the field of organic chemistry, his first publications in 1905 and 1906, while still an undergraduate student, being in this field, as was his doctoral dissertation. However, he became interested in the field of colloid chemistry as early as 1908 in connection with a study of the reaction between chromic and hydriodic acids, published in the *Journal of Physical Chemistry,* and he was publishing papers in the fields of plant and animal biochemistry shortly after he joined the staff of the Station at Cold Spring Harbor. It was here, also, that Dr. Gortner began his application of physical chemistry to biochemical phenomena which dominated a large part of his work and that of his students in later years.

The enumeration of the many scientific subjects on which Dr. Gortner published would cover several printed pages. The fields of work in which a series of papers appeared is, in itself, a formidable one and includes the following: (1) melanin; (2) the chemistry of embryonic growth; (3) physicochemical properties of vegetable saps; (4) the humin fraction in protein hydrolysates; (5) the organic matter of soil; (6) the chemical and colloidal properties of flour proteins; (7) sulfur in proteins; (8) physicochemical studies on proteins; (9) electrokinetics of colloidal systems; (10) interfacial energy and the molecular structure of organic compounds; (11) the role of water in living processes; (12) the chemistry of wood and of the pulping process. So varied were Dr. Gortner's interests that his influence was felt in the research of almost every field of agricultural science and in the investigations of the entire department of agriculture of the university. This influence extended outside of these circles into other colleges of the university and throughout the nation. For many years he carried on an extensive correspondence with research workers in his special fields in the United States and also in foreign countries.

One of Dr. Gortner's major contributions to scientific thought was his book "Outlines of Biochemistry," the second edition of which appeared in 1938. Another volume, "Selected Topics in Colloid Chemistry," contained the lectures which he gave at Cornell University in 1935–36 in connection with the George Fisher Baker lectureship which he held, and a third volume prepared by Gortner and colleagues in 1936, entitled "J. Arthur Harris, Botanist and Biometrician," was in honor of his close friend. He also contributed chapters to several comprehensive monographs.

Dr. Gortner felt that his chief contribution to science was through his students. In recent years he delivered to many audiences his lecture on "Scientific Genealogy." His intense enthusiasm for science and especially for the field of biochemistry, his exceptional fund of scientific knowledge in many fields and his easy, familiar delivery made him an inspiring teacher. An increasing number of students were attracted to his classes and to his department for graduate work. He gave freely and liberally of his time and thought to the research problems of his own graduate students as well as to those of his colleagues both in the Division of Biochemistry and in other divisions of the university; in the early days of the development of graduate work in the Division of Biochemistry he spent many hours in the laboratory working with his students. During the 25 years of his service as chief of the division, 87 students were personally directed by Dr. Gortner in their graduate research, and during the academic years 1940–42 between 60 and 70 graduate students were in residence in the division. Dr. Gortner was active in many graduate student activities outside scholastic work. For five years he was national president of Phi Lambda Upsilon, honorary chemical fraternity, and for a number of years was "god-father" of the honorary graduate scientific society, Gamma Alpha, at the University of Minnesota.

A testimonial dinner had been planned for Dr. Gortner for Friday, October 2, in honor of the twenty-fifth anniversary of his appointment as chief of the Division of Biochemistry, at which time he was to have been presented with a bound volume of more than 200 letters from those who had been associated with him as colleagues and graduate students in the division during the 25 years. The hand of fate prevented him from seeing this volume. Instead it was with heavy spirits that his colleagues and students bore his remains to their final resting place on the day when the testimonial dinner had been set.

Dr. Gortner was honored by his colleagues with appointment to many positions of responsibility in scientific research and education. In the National Research Council he was serving at his death on committees on Biochemical Nomenclature, Chemistry of Proteins, Colloid Science and Organic Chemical Nomenclature; for the American Society of Biological Chemists and the American Chemical Society he was a member of the committee on Organic Chemical Nomenclature. For three years Dr. Gortner served on the executive committee of Sigma Xi, national honorary scientific society, and on December 31, 1941, he was elevated to the position of president of the society. Last May he was awarded the Osborne Medal

by the American Association of Cereal Chemists, given by this society to scientists who have made outstanding contributions in the field of cereal chemistry.

Dr. Gortner was a scientist whose mind had no racial or international boundaries. He was especially sympathetic towards the work of scientists laboring under adverse conditions. His intensely vital personality was evidenced in the enthusiasm with which he read in every field of thought, in the keen pleasure he took in scientific debate, in his passion for photographing in color a beautiful sunset at his lake cottage, and in his hearty laugh, his pride in his family and his division and in his loyalty to those whom he loved and admired. Those who in turn loved and admired him can not understand the necessity for his removal. Science in general will miss him sorely.

L. S. PALMER

UNIVERSITY OF MINNESOTA

RECENT DEATHS

DR. SIGISMUND SCHULZ GOLDWATER, commissioner of hospitals of New York City from 1934 to 1940, an authority on the construction and administration of hospitals, died on October 23 at the age of sixty-nine years.

PROFESSOR ROBERT WILCOX SAYLES, since 1907 curator of the Geologic Museum of Harvard University, died on October 23. He was sixty-four years old.

DR. ALBERT HASSALL, bibliographer and formerly assistant chief of the Zoological Division, U. S. Bureau of Animal Industry, died on September 18 at the age of eighty-one years.

DR. GEORGE GERALD HENDERSON, emeritus professor of chemistry of the University of Glasgow, died on September 28 at the age of eighty years.

SCIENTIFIC EVENTS

THE JAMES F. LINCOLN ARC WELDING FOUNDATION

THE James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, for two and a half years has been carrying on its second industrial study on arc welding, for which 408 awards amounting to $200,000 have been made.

Results of the study show that the war industries have only begun to gain the benefits of modern arc welding; that further application of the welding process will cut expenses by hundreds of millions of dollars from the United Nations' war bill and will cut by 30 per cent. the time required to produce ships and planes. Arc welding will save an average of 300 pounds out of every ton of steel going into war production.

Papers were submitted from 46 of the 48 states, by engineers, designers, architects, maintenance men and executives throughout the industrial field. Altogether, 408 awards were made to 458 recipients. The studies for which the awards were made, according to a letter from Dr. E. E. Dreese, head of the department of engineering of the Ohio State University, chairman of the Jury of Award, indicated that

> the figures, based on representative products and structures, show a possible annual cost saving of $1,825,000,000. This includes 7,000,000 tons of steel valued at $271,000,000 and 153,000,000 man-hours of labor. This $271,000,000 is a conservative figure calculated at base prices of $34 per ton for billets and slabs and $42 for plate.
>
> One representative study in the Progress Program reported that caissons under construction and projected for naval drydocks can be built by arc welding in one third less time, at a saving of 9,000 tons of steel, $3,540,000 in cost, also allowing armor plating for bomb protection with no more steel tonnage than older construction.
>
> Another study reported that arc welding of propeller blades alone would save the aircraft industry $50,000,000 annually.
>
> Conservative estimates, based on the reports, indicate an annual saving of $100,000,000 in the vast machinery-manufacturing industry which is vital to our national security in war-time and indispensable to our way of life in times of peace.

Members of the Jury of Award were: Dr. Dreese, *chairman;* Assistant Professor R. W. Ahlquist, electrical engineering department, the Iowa State College; Associate Professor Paul Andersen, civil engineering department, the University of Minnesota; Professor Allison Butts, electrometallurgy department, Lehigh University; Professor R. L. Dowdell, metallography department, the University of Minnesota; R. G. Dukes, dean of the Graduate School, Purdue University; Professor Herbert B. Dwight, electrical engineering department, the Massachusetts Institute of Technology; Assistant Professor Fulton Holtby, foundry practice, the University of Minnesota; Professor C. A. Koepke, mechanical engineering department, the University of Minnesota; Professor Arthur F. Macconochie, mechanical engineering department, the University of Virginia; O. W. Muckenhirn, instructor of electrical engineering, the University of Minnesota; C. T. Morris, head of civil engineering, the Ohio State University; J. B. Taylor, head of the department of accounting, the Ohio State University; L. F. Van Hagan, chairman of the civil engineering department, the University of Wisconsin; Professor Chilton A. Wright, civil engineering department, Polytechnic Institute of Brooklyn.

The three principal awards were:

$13,700, First Grand Award, Captain C. A. Trexel and

A. Amirikian, director of planning and design and designing engineer, respectively, Bureau of Yards and Docks, Navy Department, Washington, D. C.: Caissons for naval dry docks. Net savings for arc-welded caissons built and under contract $1,652,000. Savings on projected construction in the immediate future $3,540,000. Savings in steel (projects built 4,200 tons) and (caissons projected) 9,000 tons.

$11,200, Second Grand Award, John L. Miller, chief metallurgist, Gun-Mount Division, The Firestone Tire and Rubber Company, Akron, Ohio: Welding the 40mm Bofors anti-aircraft gun and how various parts were changed from riveted to welded design. Cost per chassis, welded, was $76.80 less than riveted construction. The total saving with 35,000 units is estimated at $6,000,000.

$8,700, Third Grand Award, H. Thomasson, welding engineer, Canadian Westinghouse Company Limited, Hamilton, Ontario: A new type of large mercury-arc rectifier, called ignitron, which requires extremely high vacuum. On a number of items, an average of 47 per cent. was saved in cost by using arc welding instead of an alternate construction. This amounted to $63,000 per year for the company, which, at the same rate, would be $166,000 for the industry.

THE CONSERVATION OF FISHERIES IN THE GREAT LAKES

THE International Board of Inquiry of the United States and Canada which has studied for two years the conservation of fisheries in the Great Lakes, according to a special dispatch to *The New York Times,* recommended on October 20 that, based on the results of common studies of these fisheries, regulations for their management be formulated and tested by a joint agency of the two countries. The recommendations are as follows:

1. That there be common investigation of the fisheries of the Great Lakes.
2. That, in so far as investigation shows fisheries to be dependent upon a common stock or to have the same conditions, regulations for management of these fisheries be formulated and tested by a common or joint agency.
3. That where investigations are not conclusive such common regulations be applied and the results therefrom carefully determined until there is adequate proof of their effectiveness for the purpose.
4. That the attention of the agencies concerned be drawn to the need (a) for accurate statistics of the take and of the fishing effort, (b) for separate statistics for each species of fish and (c) for separate statistics for each of such districts as may be defined in common agreement.
5. That thorough tests be made of the effectiveness of planting fish in a lake or lakes in order to determine whether the present planting of fish should or should not be continued or altered.

In a supplemental report the United States members suggest a form of agreement which would vest control in established agencies in Canada and the United States, with regulation handled through the concurrent action of federal and state governments.

Members of the board were Herbert R. Gallagher, chairman, assistant director, Council of State Governments, Chicago; A. G. Huntsman, consulting director, Fisheries Research Board of Canada, Toronto; John Van Oosten, United States Fish and Wild Life Service, Ann Arbor, Mich., and D. J. Taylor, deputy minister, Game and Fisheries Department, Toronto.

The establishment of the board grew out of a series of interstate and international conferences during the past few years by the Council on State Governments for the conservation of the Great Lakes fisheries. The problem of conserving the fisheries had also long engaged the attention of the Governments of Canada and the United States, the Province of Ontario and the States bordering on the Great Lakes. The production of some species of Great Lakes fish had reached low levels.

BIOLOGICAL ABSTRACTS

Biological Abstracts announces the establishment of a seventh section, which will be devoted to "Specially Assembled Abstracts of Food and Nutrition Research" to be initiated in January, 1943. This section will consist of an assembly and reprinting of all abstracts that deal with human and animal nutrition and metabolism, vitamins, diet and diet-deficiency diseases, food composition and values, food processing and food microbiology, beverages, storage and conservation of foods, food spoilage, in short, all biological literature that pertains to foods and nutrition.

Biological Abstracts has covered this literature ever since its establishment in 1926. In previous volumes abstracts pertaining to foods and nutrition have been dispersed throughout the entire volume, hence those whose special interests lay in the foods-nutrition field were able to obtain them only through the purchase of the five original sections. The segregation of the foods and nutrition abstracts in the new section will provide an abstracting service at greatly reduced cost.

Every possible effort is being made to cover the literature completely. Efforts to obtain abstracts of publications from continental Europe, now mostly unavailable to workers in this country, are continuing. In spite of the restrictions affecting the diffusion of research information occasioned by the war more than 1,700 periodicals in the biological field are being abstracted. The new section will therefore from the beginning afford practically a complete survey of the literature.

Each volume will consist of ten issues; subscribers will receive the index to the complete edition of *Biological Abstracts.* Inquiries should be addressed to *Biological Abstracts,* University of Pennsylvania, Philadelphia, Pa.

TROPICAL MEDICINE AT TULANE UNIVERSITY

IT is reported in the *Journal* of the American Medical Association that twelve Latin American physicians joined the course in tropical medicine at Tulane University of Louisiana School of Medicine, New Orleans, in September under fellowships financed by the American Foundation for Tropical Medicine. They are Drs. M. Sanchez Basseres, Brazil; M. A. Cardenas, Chile; Benjamin Mera, Colombia; Alejandro Gonzalez L., Costa Rica; Gilberto Gomez R., Dominican Republic; Alfonso Marchan, Ecuador; Jose Pacas M., El Salvador; Jose Bustos, Mexico; Silvestre Lopez Portillo, Mexico; Carlos Calera M., Panama; Jorge Clavier, Venezuela, and Tulio Briceno, Venezuela. Dr. L. Everard Napier, director of the Calcutta School of Tropical Medicine and editor of the *Indian Medical Gazette,* recently accepted a visiting professorship in the department of tropical medicine and is expected to join the staff early in 1943. During the past spring and early summer the staff gave intensive night courses in tropical medicine to physicians in the military forces stationed in New Orleans. Dr. Ernest C. Faust, head of the division and director of laboratories of tropical medicine and consultant to the Secretary of War on tropical diseases and on epidemic diseases, lectures every two months at the Army Medical School, Washington. Drs. Faust and Joseph S. D'Antoni, assistant professor in the department, are collaborating with the division of medical sciences of the National Research Council in lecturing on tropical medicine at medical schools in the East and North during October and November. In 1941 the General Education Board of the Rockefeller Foundation gave $200,000 to enlarge the personnel of the department and to plan for a more permanent teaching program for undergraduate and postgraduate work in the field. Since 1940 the American Foundation for Tropical Medicine has provided an annual sum of $9,000 for postgraduate teaching, particularly for a special intensive course for Latin American physicians. This year two fellowship grants have been made available for North American physicians by the Lambert Pharmacal Company, St. Louis, and the Winthrop Chemical Company, New York. Since 1940 the Eli Lilly Company has provided a yearly grant of $5,000 for unrestricted research carried out under the auspices of the department. Under the program the physician receives intensive training both in laboratory and in clinical tropical medicine in addition to review work in the general field of medicine; additional training is provided by special guest lecturers who are experts in their respective fields.

THE NATIONAL CHEMICAL EXPOSITION

THE National Chemical Exposition and Industrial Chemical Conference, the second to be sponsored by the Chicago Section of the American Chemical Society, will be held from November 24 to 29 in the Hotel Sherman, Chicago.

Professor G. L. Clark, of the department of chemistry of the University of Illinois, is chairman of a committee which has arranged for a symposium of electron microscopists. Preceding the symposium there will be an address on Thursday evening, November 26, by Dr. W. K. Zworykin, associate director of the Research Laboratories of the RCA Manufacturing Company, at Camden, N. J., on "The Electron Microscope in Relation to Chemical Research." In addition to a display of one of the microscopes in operation, a hundred or more photographic prints of some of the best micrographs will be exhibited.

A group of members of the Chicago Section has been working with S. Donald Perlman, executive chemical director of the salvage section of the War Production Board, in planning an exhibit to further its campaign to salvage essential chemicals.

Special exhibits will illustrate what has been accomplished in providing substitutes and alternates for critical materials in which there is a shortage. A display is being prepared by Dr. Harrison E. Howe, of "Successful Alternates and Substitutes." W. J. Murphy is arranging for an exhibit of "New Chemicals." The committee in charge of industrial movies has arranged for a continuous program.

More than a hundred exhibitors have been assigned space. The exhibit will be approximately twice as large in floor space as the first exposition in 1940. Originally set for the Stevens Hotel, a shift to the Hotel Sherman was necessitated by the acquisition of the Stevens by the U. S. Army.

Technical sessions have been arranged for Wednesday afternoon, November 25; Thursday evening, November 26; Friday morning, afternoon and evening, November 27, and Saturday afternoon, November 28. The program is timed to afford those who wish to hear the discussions in which they are interested ample opportunity also to view the exhibit.

THE AMERICAN MATHEMATICAL SOCIETY

THE three hundred and ninety-first meeting of the American Mathematical Society will be held at the University of Notre Dame on November 27 and 28, in connection with the centennial celebration of the university. Sessions for the reading of contributed papers will be held on Friday afternoon and Saturday morning. In connection with this meeting, the University of Notre Dame will hold its annual Mathematical Symposium, the subject being "Modern Statistics." At this symposium, Professors Jerzy Neyman, of the University of California, and Abraham

Wald, of Columbia University, will each give two lectures. The titles of the lectures by Professor Neyman are "Theory of Confidence Intervals" and "On a Class of Tests Equivalent in the Limit to the Likelihood Ratio Tests," and of Professor Wald are "Outline of a General Theory of Statistical Inference" and "Asymptotic Properties of the Likelihood Ratio Tests."

The previous meeting of the society was held in New York City on October 30 and 31. On Friday morning, members were invited to attend a symposium of the Optical Society of America of invited papers on "Optical Instruments." In the afternoon, there was a symposium with the Optical Society of America on "Mathematics in the Field of Optics," with addresses by Professor J. L. Synge, of the University of Toronto; Dr. S. Q. Duntley, of the Massachusetts Institute of Technology; Dr. R. C. Jones, of the Bell Telephone Laboratories, and Professor Parry Moon, of the Massachusetts Institute of Technology. On Saturday, the sessions for contributed papers were held at Columbia University. In the afternoon, Professor Salomon Bochner, of Princeton University, delivered an address, by invitation of the program committee, on "Continuation of Analytic Functions in Several Variables."

SCIENTIFIC NOTES AND NEWS

A SYMPOSIUM on "The Physical and Chemical Organization of the Cytoplasm" will be held at the University of Chicago on November 13 in celebration of the seventy-fifth birthday of Professor R. R. Bensley. During the past ten years Dr. Bensley has separated a number of cytoplasmic constituents from the cytoplasm and subjected them to chemical analysis. He was for over thirty years director of the Hull Laboratory of Anatomy at the University of Chicago, and these pioneering studies on cytoplasm have been made in the ten years since his retirement.

AT the Richmond meeting of the Southern Medical Association, held on November 10, 11 and 12, the research medal of the association will be presented to Dr. Perrin H. Long, professor of preventive medicine at the Johns Hopkins University School of Medicine, "in recognition of his outstanding contributions to the knowledge of bacteriology and chemotherapy."

DR. C. VICTOR VIGNES, dean emeritus of the School of Dentistry of Loyola University, was honored recently by the dentists of New Orleans with a formal dinner in recognition of his fifty years of service to dental education and to the dental profession.

DR. WALTER H. SNELL, chairman of the department of botany of Brown University, has been appointed Stephen T. Olney professor of botany.

PROFESSOR W. LAWRENCE FAITH, of the Kansas State College, Manhattan, has been appointed professor of chemical engineering and head of the department at the State University of Iowa.

ALFRED TARSKI, the Polish mathematician and logician, formerly of the University of Warsaw, has joined the faculty of the University of California at Berkeley for the duration of the war. Dr. Tarski holds a Guggenheim fellowship, but prefers a post where he can continue teaching. He came to the United States in 1939 to attend a mathematical congress and to lecture at Harvard University. War conditions made it impossible for him to return to Poland. He has therefore decided to become a citizen of this country.

DR. WILLIAM CROCKER, managing director of the Boyce Thompson Institute for Plant Research, Inc., Yonkers, N. Y., will spend the winter quarter, from January to March, 1943, at the University of Washington, as Walker-Ames visiting professor. He will give a series of ten lectures on "Special Chapters in Plant Physiology," dealing with several projects developed at the institute during the last eighteen years. He will also give several popular lectures and conduct a seminar in botany.

DR. MATILDA M. BROOKS, research associate in biology at the University of California at Berkeley, has received the Grace Lavayea Fellowship of the Kappa Alpha Theta National Fraternity for the year 1942-1943, and also a grant-in-aid for research from the same source.

DR. R. ADAMS DUTCHER, head of the department of agricultural and biological chemistry at the Pennsylvania State College, has been appointed a member of a sub-committee of the Food and Nutrition Board of the National Research Council.

DR. E. R. GILLILAND, professor of chemical engineering at the Massachusetts Institute of Technology, and Ray P. Dinsmore, of the Goodyear Tire and Rubber Company, Akron, Ohio, are among the consultants appointed by the rubber director, William M. Jeffers, to study the technical aspects of the program.

DR. NED H. DEARBORN, dean of the division of general education of New York University, has been named executive vice-president and managing director of the National Safety Council, succeeding W. H. Cameron, who is retiring after serving for almost thirty years as managing director. Dr. Dearborn will

direct the greatly expanded war-time program now being conducted by the council.

DR. EDWARD S. ROGERS, acting assistant commissioner for medical administration of the New York State Department of Health, Albany, has been appointed director of the Office of War Nutrition Service of the New York State War Council. He will direct the work of all the departments and agencies that are concerned with problems related to nutrition. Dr. Alvin A. Florin, Woodmere, assistant district health officer, has been appointed assistant to Dr. Rogers.

DR. C. H. GRAVES, assistant professor of mathematics at the Pennsylvania State College, has leave of absence to enable him to serve as associate educational statistician in the Federal Security Agency, Office of Education, Washington, D. C.

DR. D. K. TRESSLER, head of the division of chemistry of the New York State Agricultural Experiment Station at Geneva, has presented his resignation, effective in January, to accept a position with the General Electric Company at Bridgeport, Conn. He will conduct research in the field of food refrigeration.

DR. FRANK E. EGLER, assistant professor of forest botany at the New York State College of Forestry, Syracuse, N. Y., has been appointed the first director of the newly established Experiment Station of the Chicle Development Company, with business offices at 500 Fifth Avenue, New York, N. Y., and field headquarters at Honey Camp, British Honduras, Central America. The Chicle Development Company is the Latin American subsidiary of the Beech-Nut Packing Company and the American Chicle Company. Dr. Egler maintains his affiliation with the New York State College of Forestry.

DR. M. DON CLAWSON, director of dental education at Meharry Medical College, who has served twelve years in the Near East, has been placed at the head of a mission to the Near East sponsored by the American Dental Association. The commission will make a survey in that area of the dental needs of the United Nations.

DR. ERNEST CARROLL FAUST, president of the American Society of Tropical Medicine, which meets at Richmond conjointly with the Southern Medical Association, will deliver the presidential address at the luncheon of the society on November 11. He will speak on "Horizons of American Tropical Medicine." The address of Dr. Herbert C. Clark, president of the American Academy of Tropical Medicine, will be given in the evening at the dinner of the academy. His subject will be "Some Impressions of Medical Practice in the Tropics."

THE third Alvarenga Prize Lecture was delivered before the College of Physicians of Philadelphia and the Philadelphia County Medical Society on October 14 by Dr. Edwin J. Cohn, professor of biologic chemistry and head of the department of the Harvard Medical School. His subject was "The Plasma Proteins: Their Properties and Functions."

DR. J. C. DRUMMOND, scientific adviser to the British Ministry of Food, delivered the Harben Lectures for 1942 at the Royal Institute of Public Health and Hygiene, London, on October 26, 27 and 28. His subject was "Problems of War-time Nutrition."

DR. R. M. TAYLOR, of the Rockefeller Foundation and the head of the virus department of the National Department of Hygiene, recently lectured on influenza at the Academia Nacional de Medicina of Buenos Aires.

BECAUSE of the war and the attendant difficulties, bringing increased burdens upon the membership of the Mineralogical Society of America, together with the difficulties of travel and arranging accommodations, the council of the society has voted to cancel the meeting originally scheduled for Ottawa from December 29 to 31. Abstracts of papers to be published will be received as usual, but publication of the official program for the annual meeting will be omitted this year. Abstracts submitted will be published in the March issue of the *Journal*, together with the report on the affairs of the society for 1942.

THE dedication of the Mineral Industries Building of West Virginia University was attended by five hundred delegates and visitors from the state and from neighboring states. The first day, October 16, was devoted to registration and general meetings and the second to divisional meetings.

THE industrial chemical investigations of the Regional Soybean Industrial Products Laboratory of the U. S. Department of Agriculture have been transferred from the University of Illinois to the Northern Regional Research Laboratory at Peoria, leaving at the university only an agronomic laboratory and oil, meal, engineering and analytical units. Dr. T. H. Hopper, director of the laboratory, has been appointed chief of the analytical and physical chemical division of the Southern Regional Research Laboratory at New Orleans.

THE Committee on Public Health Relations of the New York Academy of Medicine has made a report on oxygen therapy, a method of treatment which is growing in importance and in scope of application. It urges in eight recommendations that certain standards and regulations be adopted on the medical procedures to be followed and on the equipment to be used.

THE Parmly Foundation for research in hearing has been established at the Illinois Institute of Technology with an endowment of $300,000 by the late Samuel P. Parmly, Jr., who, though deaf, was a successful and well-known Chicago business man. The foundation will concentrate on the physics of hearing and will cooperate with the medical profession in studying other aspects of the problem involved.

ACCORDING to an announcement appearing in the daily press, the Swedish-American News Exchange was informed on October 16 from Stockholm that the Nobel Prizes would not be awarded this year. The prizes have not been awarded since 1939.

THE American Standards Association recently announced approval as American standards of twenty-three standards and specifications developed by the American Society for Testing Materials. All are of considerable interest to manufacturers and purchasers in the mechanical industries. Seven deal with wrought-iron and wrought-steel pipe and tubing; twelve cover specifications for testing materials for boilers, pressure vessels, flanges and boltings, locomotives, etc.; two cover malleable iron castings and cupola malleable iron and two deal with fabricated steel bars and welded steel wire fabric for concrete reinforcing. These twelve specifications cover materials for boilers, pressure vessels, flanges, locomotives, etc.

DISCUSSION

DEFORMATION OF ROCK STRATA BY EXPLOSIONS

THE greatest natural explosions produced on earth are due to the fall of giant meteorites and to volcanic explosions. Those of the first sort produce meteorite craters, those of the second calderas. Craters of both origins may be so nearly alike that surface configuration offers no sure criterion for their differentiation. Effects of the two types of explosions on the bed-rock are however quite unlike. Meteoric explosions may produce intense deformation in rock layers beneath and adjacent to craters; volcanic explosions produce little or no such deformation.

Examples to support this are found not far apart in Arizona. The famous "Meteor Crater," 4,000 feet across and 600 feet deep, records the impact and explosion of a giant meteorite, fragments of which were blown by the thousands over the surrounding plains. Sedimentary rocks exposed in the walls of the crater are tilted radially away from the center, and variation in the dips around the periphery defines a bilateral structural symmetry.[1] The brecciated wall rocks are broken by radial faults.

Evidences for violent volcanic explosions attended by eruption of lava and fragmental materials are found in the Hopi Buttes area in northeastern Arizona.[2] Some of the calderas thus formed were the size of Meteor Crater. Many have been deeply eroded, so that the structure of the underlying and adjacent bed-rock is displayed. Hack, who has studied and mapped these features in admirable detail, states that in no example was the bed-rock deformed as a result of the explosions.

From comparison of meteorite craters with volcanic calderas, it may be concluded that sudden deformation of bed-rock by flexing and faulting is characteristic only of explosion craters of the first type.

No one knows by direct observation how a dissected meteorite crater might appear or what types of structures would be revealed by deep erosion. However, the excavations at Odessa Meteorite Crater in Texas have shown that the rim rocks are folded and faulted and that deformation is highly localized around the periphery.[3] Generalizing from this observation and from the fact that fractured rim rocks of meteorite craters are usually elevated so as to dip away from the center in all directions, the type of structure to be expected beneath a large meteorite crater would consist of a central dome flanked by folds and broken by faults and joints.

Structures of this general pattern have long been known, and it is highly improbable that some of them can ever be accounted for in terms of stresses originating within the earth. Examples are the Flynn Creek structure of Tennessee,[4] formed during the Paleozoic, the Sierra Madera dome of western Texas,[5] formed between Permian and Cretaceous time, and several of the domical structures that Bucher[6] has called "cryptovolcanic."

Presumably meteorites have been falling since the beginning of geologic time, and it would be strange indeed if the lithosphere did not somewhere bear the scars of their impact and explosion.[7] The structures

[1] D. M. Barringer, *Proc. Acad. Nat. Sci. Philadelphia*, 57: 861–866; 66: 556–565.

[2] J. T. Hack, *Bull. Geol. Soc. Am.*, 53: 335–372.

[3] E. H. Sellards and G. Evans, mimeographed circular dated September 1, 1941, *Bur. Econ. Geol.*, University of Texas.

[4] C. W. Wilson and K. E. Born, *Jour. Geol.*, 44: 815–835.

[5] P. B. King, *Univ. Texas Bull.*, 3038: 123–125.

[6] W. H. Bucher, Rept. 16th Internat. Geol. Cong., p. 1055–1083.

[7] J. D. Boon and C. C. Albritton, Jr., *Field and Lab.*, 5: 1–9, 53–64; 6: 44–64.

noted above and others like them are more likely to have been formed as a result of the lateral escape of earthly material in front of a downward plunging giant meteorite and the rebound that followed its impact.

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THE NON-UTILIZATION OF LACTIC ACID BY THE LACTATING MAMMARY GLAND

IT was first reported by Graham,[1] working with goats, that the lactating mammary gland utilized lactic acid. This was apparently confirmed by Shaw, Boyd and Petersen[2] on lactating cows. Both studies were based on the decrease in blood lactic acid in the passage of the blood through the mammary gland. More recently a criterion of the excitability of the animal was made available by the finding,[3] based on hemoglobin values, that any disturbance of the animal was invariably reflected in a considerable change in the concentration of the blood traversing the gland; whereas in the quiet animal there were little or no detectable blood concentration changes.

This report deals with a re-examination of the role of blood lactic acid in milk secretion based on arteriovenous differences of the lactic acid of blood in its passage through the mammary gland. Lactic acid was determined by a modification of the method of Barker and Summerson.[4] In 17 experiments in which the concentration of the blood traversing the mammary gland was less than 0.5 per cent. and the animals showed no apparent excitation, there was a mean arteriovenous lactic acid difference of only 0.52 mg. per cent. The standard error being 0.32, the difference is not significant. In 17 experiments, in which the blood concentration in the gland exceeded 0.5 per cent. and the animals were obviously excited, there was an apparent utilization of 2.4 mg. per cent. of lactic acid. The standard error of 0.70 demonstrates that this difference is highly significant and indicates that the reported utilization of lactic acid by the active gland was only an apparent utilization due to excitation.

The mean of the arterial lactic acid values of the animals in the excited group was 10.1 mg per cent.; whereas that of the quiet group was only 7.3 mg per cent. It is believed that the apparent utilization with excitation is due to a sudden concentration of lactic acid in the blood in which there is a diffusion of lactic acid into the glandular tissue, resulting in a temporary disproportion in the lactic acid concentration of the blood passing through the gland. This is further substantiated by experiments on both cows and goats under nembutal anesthesia. Arteriovenous samples drawn 10 to 15 minutes after placing the animals under anesthesia, at which time the blood lactic acid was still high due to excitation, showed an apparent utilization of from 2.6 to 7.7 mg per cent. of lactic acid. Samples drawn after the animals were under anesthesia 30 to 45 minutes, at which time the blood lactic acid approached normal, showed no utilization. It is concluded that the lactating mammary gland does not normally utilize blood lactic acid. A more extensive account of this work will be published soon.

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[1] W. R. Graham, Jr., *Jour. Biol. Chem.*, 122: 1, 1937.
[2] J. C. Shaw, W. L. Boyd and W. E. Petersen, *Proc. Soc. Biol. and Med.*, 38: 579, 1938.
[3] J. C. Shaw and W. E. Petersen, *Proc. Soc. Biol. and Med.*, 42: 520, 1939.
[4] S. B. Barker and W. H. Summerson, *Jour. Biol. Chem.*, 138: 535, 1941.

AN ENDORSEMENT OF THE USE OF GENERIC NAMES AS COMMON NOUNS

CERTAIN advantages in the use of generic names as common nouns, when the species is clearly understood, were discussed recently by Dr. S. O. Mast (SCIENCE, 96: 252, 1942); *e.g.*, the use of "some paramecia" instead of "some specimens of *Paramecium*" or "some *Paramecium*." The second phrase, as Dr. Mast points out, comes to be burdensome and repetitious; the third, as he explains, involves a grammatical error and a taxonomic invalidity, in that there is and can be only one "*Paramecium*," namely, the single protozoan genus *Paramecium*.

In spite of the advantages cited—economy of printed space, avoidance of burdensome phraseology and elimination of grammatical inaccuracies—some authors and editors are distinctly reluctant to use generic names as common nouns. As an extreme case of such reluctance I may mention a personal experience. A paper that I submitted to a British journal was adjudged unacceptable because of my use of the expressions "an amoeba" and "the amoebae." Only upon the capitalization of the initial letter of "amoeba" and "amoebae" was the paper accepted, although "amoeba," with plural "amoebae" or "amoebas," is recognized as a common noun in the Oxford Dictionary, and hence there is no need to capitalize it.

In my work on *Didinium* and other protozoan genera, I have consistently used the generic name as a common noun, preferring in the interest of brevity "ten didinia" to "ten specimens of *Didinium*," and in the interest of grammar the constructions "ten

didinia" and "the didinia were" to "ten *Didinium*" and "the *Didinium* were." Nevertheless, expressions identical in form to the last-mentioned two are to be found in current protozoological literature.

Actually, there is nothing new or radical in the use of generic names as common nouns. The practice is adequately supported by the authority that precedent invariably confers. For example, the following are some common animal names (hence common nouns) that are accepted in Webster's New International Dictionary, second edition: alligator, amoeba, arbacia, bison, hippopotamus, paramecium, rhinoceros and stentor. Yet each of these common names becomes a generic name when written with a capital initial letter and preferably italicized, though editorial practice varies with reference to italics; in other words, each is a generic name used as a common noun. In the plant world cases are even more numerous because of the wide popular interest in gardening and horticulture; *e.g.*, acacia, chrysanthemum, geranium, narcissus, rudbeckia and rhododendron. In the use of these and similar common names in scientific writings, it is merely necessary for the author to make clear what species is under consideration.

In view of the convenience which the practice embodies and the sanction which precedent has already conferred on it with reference to many of the more widely known animals and plants, there seems to be no logical reason for investigators and editors to look with disfavor on an author's judicious use of a generic name as a common noun.

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SCIENTIFIC BOOKS

APPLIED MATHEMATICS

Operational Methods in Applied Mathematics. By H. S. CARSLAW and J. C. JAEGER. Oxford: Clarendon Press. 1941.

THE title of this book might give a better indication of its contents if the words "Avoidance of" were prefixed thereto. For, the outstanding virtue of the book is that it dispels the mysticism formerly attached to the so-called operational calculus. After a brief introductory chapter tracing the historical development of the subject and giving due recognition to Heaviside, the real originator of the method, no further use of operators as such appears. Thus the book serves to put the subject on a firm basis in such a clear and simple way that even a student who is not too familiar with mathematics can learn the technique and understand the underlying theory.

The fundamental tool for the elimination of the operational method is the Laplace transform

$$x^*(p) = \int_0^\infty e^{-pt} x(t)\,dt,$$

which "carries" the function $x(t)$ into its "transform" $x^*(p)$. To solve an ordinary linear differential equation with constant coefficients in the unknown function $x(t)$ one transforms the equation by the above integral. Due to the fact that the transform of the derivative $x'(t)$ differs from $p\,x^*(p)$ by a constant (which is determined by the boundary conditions) the differential equation is transformed into an algebraic equation in $x^*(p)$. After solving this it remains only to discover the function $x(t)$ from its transform. In the first chapter this is done by use of a table of the simpler Laplace transforms. Verification of the validity of the process is left for a later chapter. Many examples and exercises are given so that the technique of the method can be thoroughly mastered.

After several applications to physical problems the authors return in Chapter IV to the theory behind the method. With a minimum of the theory of the Laplace integral and the elements of the calculus of residues they show that the method always gives a solution in the linear case described above. Partial differential equations are next treated. Here the Laplace transform serves to reduce the number of variables by one. Thus a differential equation in two independent variables becomes an ordinary equation after the transformation. For partial equations no general validity theorem is established, but each solution is verified directly. The remainder of the book consists of applications to heat conduction, hydrodynamics, various electrical, mechanical and wave problems.

The book strikes an excellent compromise between the rigor required in a mathematical text and the technical skill demanded by the engineering student. Ideals of precision are established by setting forth the foundations strictly. Then later verifications are left to the student who has caught the feeling for careful mathematical procedure. In this connection it might be in order to express regret that the difficult problem of the uniqueness of solutions is not at least mentioned. It is further to be deplored that in a book of this character there should be no mention of the Stieltjes integral. This integral is so obviously the correct tool for physical problems that it is difficult to understand why it has not found its way into physics texts. By its use the somewhat apologetic discussion of "impulsive functions" in Appendix III could be replaced by something less distasteful to the

mathematician. This is rather a comment on the existing dissemination of information about the Stieltjes integral rather than on the authors' choice of material. For there has been an evident effort in this work to meet the student of applied mathematics on his own ground.

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SOCIETIES AND MEETINGS

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS

HEREWITH is presented the eleventh annual report of the Pickering Memorial astronomer and the recorder of the American Association of Variable Star Observers. The past year, during most of which our own country has been involved in war, has, in spite of difficulties incidental to such conditions, been productive of results in the field of variable star observations and the studies of the variables themselves. With the decrease in time occupied in the routine care of the somewhat smaller number of observations which have been communicated, the recorder has been able to devote considerably more time to the long-planned statistical study of the variables—principally those of long period—which have for more than three decades been on the observing list of the association.

Not only have the reports from foreign observers been necessarily fewer and smaller, but our own observers have been fewer in number, as some of them have either joined the armed forces or have been engaged in other wartime activities.

Among those who are known to be actively participating in the armed services are Ensign C. B. Ford, formerly of Smith College; Private J. Russell Smith, formerly of Lubbock, Texas, and Captain A. T. Murphy, formerly of San Francisco, California. Foster D. Brunton, of Guam, is a prisoner of war, as is doubtless Father Depperman, in Manila.

The library continues to be used to some extent. Acquisitions during the past year numbered 168, including 43 volumes and parts of volumes, besides numerous reprints. Gifts of eleven books have been made by H. B. Webb, Anton Kovar, E. H. Jones and the recorder.

Slides: Again attention is called to the excellent collection of slides which is available for loan to members. It could be used much more extensively.

Telescopes: The three-inch telescope formerly owned by the late Sigmund K. Proctor has been donated by his mother, Mrs. Helene F. Proctor, as a memorial, and is now on loan to Mrs. Federer.

Publications: The *Bi-Monthly Bulletin* continues to serve a useful purpose. Three numbers of *Variable Comments* have been issued: one deals with the 1941 fall meeting, the report written by C. B. Ford; another contains the tenth annual report of the recorder; and the third covers the A.A.V.S.O. Get-together at New Haven in June, 1942, by Helen S. Federer.

"Variable Star Notes" appear regularly in *Popular Astronomy* and as a Harvard reprint at the end of the year. The original observations appear in the Harvard *Annals,* and Nos. 2, 3 and 4 of Volume 110 have been issued. Instead of containing the observations for each quarter separately, individual numbers now cover six months or more of observations.

Side Activities: It is to be regretted that activities other than the regular variable star observing program have not received the attention which was given them in former years. Doubtless the war can be blamed for much of the seeming neglect of these phases of our work. The Nova search has dropped considerably and the photographic research has been practically nil. The work of the occultations committee will be detailed by the chairman of that committee.

Professor Bobrovnikoff, of Perkins Observatory, Delaware, Ohio, hopes that members of the association will cooperate with him in the estimations of the brightness of comets. He has shown that some valuable cooperative work could be done by trained variable star observers. He is willing to give advice in this field of observing to all inquirers.

Research Problems: The hope expressed by the recorder in his tenth report, that he would be able to start on a real campaign of the discussion of the long-period variables, has been fully realized. During the past ten months he has discussed 250 variables. This has involved the handling of approximately 450,000 observations covering, in general, the past twenty years. The discussion has included not only new derivations of the mean light curves, but also the final determination of dates of maximum and minimum—about 12,500 dates—as well as the accumulation of an abundance of material for studying numerous correlations which pertain for the variables, especially the Me stars.

Results on a hundred of the variables have appeared in instalments of twenty-five each in *Variable Star Notes* for this year, together with diagrams of the light curves.

The SS Cygni and R Coronae Borealis stars have been well observed. SU Tauri dropped to a deep minimum, and RY Sagittarii to a shallow minimum, according to recent reports.

Annual Summary: Again, we must record a falling off in the number of observations received during the year, a total of 33,090 observations as against 37,443 for last year. Observations are meager for a few stars, especially the southern ones, but on the whole,

despite the smaller number of observations, the continuity of the light curves has been well maintained.

Cyrus F. Fernald, of Wilton, Maine, again heads the list, with a total of 4,206 observations. He observed on 143 nights, and reports having spent 207 actual hours at observing, an average of twenty stars per hour. This is a remarkable record, and well attests the value of having a finely mounted and properly adjusted telescope—an 8-inch Springfield reflector—combined with considerable experience and plenty of enthusiasm. How much time Mr. Fernald spends in listing his reports would be of interest.

In the 2,100 to 2,300 class are Holt, of Tucson, Ariz.; deKock, of South Africa; Cilley, of Lewisburg, W. Va.; and Peltier, of Delphos, Ohio. In the 1,100 to 1,800 class are Mrs. Kearons, and Messrs. Hartmann, Jones and Chandra.

Nine observers made between 500 and 1,000 estimates each, and eleven, between 200 and 500. These twenty-nine observers made 87 per cent. of all the observations, but the other 61 contributors, 13 per cent., have added materially to the cause.

Special mention should be made of the interest shown by our Canadian observers. We now have five active contributors from that country, with a total of 914 observations for the year. Our South African observers contributed 4,179 observations; from India came 1,602, and from Mexico, 952. Australia, Argentina and Japan contributed 372, 96 and 87, respectively. Our 74 American observers accumulated a total of 24,888 observations.

The eleven observers of the Milwaukee Astronomical Society contributed 1,518 observations; the three from the Fall River, Mass., group, 2,630; and the three in Portland, Maine, 431.

Personnel: Mrs. Helen S. Federer has acted as Pickering Memorial assistant throughout the year. She has acted as custodian of the records, plotting the observations and picking up discrepancies when they occurred. She has also looked after the correspondence and mailing out of *Bulletins*, *Annals* and so forth, thus allowing the recorder to spend much of his time on the discussion of the variables.

When the million mark will be attained is still a question, but to date the American Association of Variable Star Observers has reached a grand total of 880,000 observations in the 31 years since it began its work. We must not permit the variables to go unobserved, even in these war-torn times; an ever-continuing history of the activities of our variables must be maintained, in so far as it is possible. But first and foremost must come the winning of this war, and the sooner the better for civilization and for science.

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SPECIAL ARTICLES

PIMELIC ACID, BIOTIN AND CERTAIN FUNGI

EVIDENCE that pimelic acid is utilized by the diphtheria bacillus for the synthesis of biotin has been presented by du Vigneaud, Dittmer, Hague and Long.[1] Eakin and Eakin[2] report that the synthesis of biotin by *Aspergillus niger* was increased by the addition to the medium of pimelic acid, and the effect was enhanced by cysteine or cystine. However, du Vigneaud and associates found that pimelic acid did not replace biotin in its growth-stimulating effect on yeast. We have attempted without success to replace biotin with pimelic acid for thirteen fungi which suffer from a biotin deficiency.

The following organisms were used in one series of experiments: *Ceratostomella ips* #255, *C. ips* #438, *C. microspora*, *C. montium*, *C. obscura*, *C. penicillata*, *C. pini*, *C. radicicola*, *Grosmannia serpens*, *Fusarium avenaceum*, *Neurospora sitophila* 56.2 and *N. tetraspora* S_1. None of these fungi makes more than slight growth on a mineral-dextrose medium containing asparagine and purified agar unless biotin is present. The addition of 0.05 μ g of biotin to a tube containing 8 ml of the basal medium permits luxuriant growth.[3]

Negative results were obtained when the 0.05 μ g of biotin was replaced with 0.05 μ g of pimelic acid. No benefit was observed when the quantity of pimelic acid was increased to 0.1 μ g per tube containing 8 ml of medium.

Sulfur is furnished in our basal medium as $MgSO_4$. The medium used for the cultivation of the diphtheria bacillus contained *l*-cystine. Eakin and Eakin found that cysteine or cystine markedly increased the formation of biotin by *Aspergillus niger* in the presence of pimelic acid. However, none of the twelve fungi listed above grew when 0.1 μ g of pimelic acid and 1 mg of *l*-cystine, 0.1 μ g of pimelic acid and 1 mg of glutathione or 0.1 μ g of pimelic acid and 1 mg of methionine were added to the basal medium instead of biotin. Excellent growth was obtained when the pimelic acid in the above media was replaced by

[1] Vincent du Vigneaud, Karl Dittmer, Eleanor Hague and Barbara Long, SCIENCE, 96: 186, 187, 1942.

[2] Robert E. Eakin and Esther A. Eakin, SCIENCE, 96: 187, 188, 1942.

[3] Some of these fungi must be supplied also with thiamine or pyridoxine or with both vitamins in addition to biotin.

0.1 μ g of biotin methyl ester, which shows that the failure to grow in the tubes containing the pimelic acid was because the pimelic acid did not replace biotin, not because the medium was injurious; du Vigneaud and associates obtained maximum growth of the diphtheria bacillus under their experimental conditions with 1.5 μ g of pimelic acid, and a marked effect with 0.05 or 0.1 μ g. Eakin and Eakin, however, used as much as 1 mg of pimelic acid per culture, and report that 20 μ g per 12 ml culture gave maximum results. We obtained no growth from the addition per tube of the basal medium 0.1 mg of pimelic acid and 1 mg of *l*-cystine, or 1 mg of pimelic acid and 1 mg of cystine. Growth was obtained when 0.1 μ g of biotin was added to these media, demonstrating that lack of growth in the media containing pimelic acid was because of insufficient biotin, or physiologically equivalent substances, and not because of too much pimelic acid.

Ashbya (*Nematospora*) *gossypii*, the organism used by Kögl as a means of bioassay in the original isolation of biotin, was also tested.[4] Negative results were obtained when 1 μ g or 100 μ g of pimelic acid were added in place of biotin to 8 ml of a basal medium and when biotin was replaced with 1 μ g or 100 μ g of pimelic acid together with 1 mg of *l*-cystine. The results were negative also when the medium containing pimelic acid or pimelic acid and *l*-cystine was further supplemented with 1.5 mg of casein hydrolysate per tube.

It appears that the thirteen fungi we used are not able to synthesize biotin from pimelic acid, or from pimelic acid and *l*-cystine, under our experimental conditions. This should not be interpreted to mean that other organisms can not construct biotin from pimelic acid and *l*-cystine, nor that pimelic acid is not a precursor of biotin. The relation of microorganisms to thiamine and its thiazole and pyrimidine intermediates have demonstrated that some organisms have no synthetic power for thiamine and require it in molecular form; others have incomplete synthetic power and can construct the vitamin if furnished the proper intermediates, but not otherwise; while still others are able to make thiamine from the minerals and sugar in a basal medium. A somewhat similar situation may exist with regard to biotin. If it does, the fungi we have used appear to require biotin as such.

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[4] *Ashbya* was grown on a modification of the medium used by Kögl and Fries which contains thiamine and *i*-inositol.

THE RH FACTOR AND RACIAL ORIGINS[1]

IN 1940 a new factor (Rh) in human blood was described[2] which is present in the blood cells of about 85 per cent. of white individuals (Rh-positive type). This blood property was found to be inherited as a simple mendelian dominant by a pair of allelic genes, *Rh* and *rh*.[3] Investigations on the distribution of the Rh factor among Negroes in New York City revealed a somewhat lower incidence of the Rh-negative type, while in full-blooded American Indians the Rh-negative type appears to be practically absent.[4] The extension of these studies to other races should yield results of significance from the standpoint of racial origins.

To account for the present distributions of the Rh factor in white individuals and in American Indians, a number of hypotheses could be considered, analogous to those proposed to explain the distribution of the four blood groups. Two main possibilities will be discussed: (1) That man was originally Rh-positive and that the present incidence of the Rh-negative type resulted from mutations from gene *Rh* to gene *rh*. While this might conceivably account for the exceptional occurrence of Rh-negative individuals among American Indians, to explain the higher incidence of the *rh* gene (almost 40 per cent.) in white individuals one would have to postulate an improbably high rate of mutation. (2) Another possibility is that there were originally two or more races, some predominately or exclusively Rh-positive, others Rh-negative, and that by crossing the present distribution of the Rh factor resulted.

Of significance with regard to this problem is the relationship that has been demonstrated by Levine *et al.* between the Rh factor and erythroblastosis foetalis, a disease responsible for a certain number of stillbirths and neonatal deaths.[5, 6, 7, 8, 9] In the typical case, the mother is Rh-negative, the father Rh-positive and the fetus Rh-positive, the latter having inherited the Rh factor from the father. Due presumably to some defect in the placenta, fetal blood es-

[1] From the Serological Laboratory of the Office of the Chief Medical Examiner of New York City. Aided by a grant from the Carnegie Foundation and the Committee on Human Heredity of the National Research Council.

[2] K. Landsteiner and A. S. Wiener, *Proc. Soc. Exp. Biol. and Med.*, 43: 223, 1940.

[3] K. Landsteiner and A. S. Wiener, *Jour. Exp. Med.*, 74: 309, 1941.

[4] K. Landsteiner, A. S. Wiener and G. A. Matson, *Jour. Exp. Med.*, 76: 73, 1942.

[5] P. Levine, E. M. Katzin and L. Burnham, *Jour. Am. Med. Assoc.*, 116: 825, 1941.

[6] P. Levine, P. Vogel, E. M. Katzin and L. Burnham, SCIENCE, 94: 371, 1941.

[7] P. Levine, L. Burnham, E. M. Katzin and P. Vogel, *Am. Jour. Obstet. and Gynec.*, 42: 925, 1941.

[8] L. Burnham, *Am. Jour. Obstet. and Gynec.*, 42: 389, 1941.

[9] A. S. Wiener, *Am. Jour. Clin. Path.*, 12: 302, 1942.

capes into the maternal circulation, and in susceptible individuals the production of anti-Rh isoantibodies results. These antibodies filter through the placenta into the fetus and destroy its blood cells and in that way give rise to the disease.

At first sight, one might conclude that since only Rh-positive babies are affected, this mechanism operates in a selective manner so as to eliminate the Rh-positive type. As a matter of fact, all the affected infants are heterozygous, genotype *Rhrh*, so that equal numbers of *Rh* and *rh* genes are lost every generation. The effect of the loss of these genes over a period of many generations on the distribution of the Rh factor is readily computed as follows:

Let us assume that we are dealing with a population of constant size containing x *Rh* genes and y *rh* genes. The initial distribution of the genes would then be as follows:

$$Rh_0 = \frac{x}{x+y} \qquad rh_0 = \frac{y}{x+y}$$

If the number of fetuses and newborn that die from erythroblastosis during one generation is c, then the distribution of the genes during the second generation would be:

$$Rh_1 = \frac{x-c}{x+y-2c} \qquad rh_1 = \frac{y-c}{x+y-2c}$$

Accordingly, if at the onset the number of *Rh* genes is equal to the number of *rh* genes, this process would have no effect on the relative distributions of the genes. If the incidence of the two genes is unequal, however, the less frequent gene would be affected to a greater extent than the more common gene, so that eventually, other things being equal, over a period of thousands of generations, the incidence of the former would be substantially reduced and it might even be practically eliminated.

These results offer further evidence against the mutation theory as an explanation of the present distribution of the Rh factor in white individuals. Even assuming a rate of mutation from *Rh* to *rh* (or *vice versa*) higher than any so far recorded for *Drosophila* and man, this selective action of isoimmunization against the less frequent gene would effectively prevent a population originally completely Rh-positive from attaining as high an incidence of the Rh-negative type as 15 per cent. On the other hand, if one assumes the existence of populations in the past (and possibly still surviving at the present time) consisting almost exclusively of Rh-negative individuals, then from crosses with other populations consisting largely of Rh-positive persons (like the American Indians) a hybrid population could result with a serological composition resembling that of the white individuals of New York City.

In conclusion, it should be mentioned that, as Haldane[10] and Wyman and Boyd[11] have pointed out, if we go back to Paleolithic times when man was presumably a rare animal, chance probably played a large part in modifying gene frequencies. In large populations, however, chance has only a negligible effect, so that at least during post-glacial times racial mixture must have been the most important factor influencing the frequencies of the genes *Rh* and *rh*.

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[10] J. B. S. Haldane, *Human Biology*, 12: 457, 1940.

[11] L. C. Wyman and W. C. Boyd, *Am. Anthrop.*, 37: 181, 1935.

VITAMIN A AND THE THYROID[1]

THERE is a theory that an antagonism exists between vitamin A and the thyroid. The evidence for this has been collected by Smith and Perman,[2] who have published evidence showing that in short experiments there is some counteraction of thyroxin by carotene. More recently Belasco and Murlin[3] in a somewhat similar experiment showed that vitamin A lowered the metabolic rate of hyperthyroid rats. No very logical reasons have been offered for such antagonism, if it exists, however, and close examination of results so far published reveal many discrepancies. It was felt, therefore, that further study was justified, and the following experiments were performed.

The sleeping metabolic rate was determined for 8 rats, 5 male and 3 female. After the range had been established, each rat was given 200,000 U. S. P. XI units of vitamin A[4] per kilogram daily by stomach tube. The concentrate was in oil solution, and contained negligible amounts of vitamin D. The volume of oil fed was between 0.2 cc and 0.6 cc daily. After 50 days of administration of the vitamin at this level (in one case after 34 days) desiccated thyroid powder, U. S. P. XI, was given in addition to the vitamin. The thyroid was given in amounts ranging from 0.25 to 0.35 gm per kilogram daily as a water suspension by stomach tube. The metabolic rate was determined at weekly intervals throughout. In no case did the vitamin A alone cause any significant alteration in the level of metabolic rate. When thyroid was fed in addition to the vitamin, the mean increase in metabolic rate was 25.5 per cent.

A second group of 4 rats, 3 females and 1 male, was given the same dose of thyroid powder after the range of metabolic rate had been determined. This dose caused a mean elevation of 58 per cent. in the metabolic rate. After this effect had been established, vitamin A was administered in addition to the thyroid,

[1] Part of the expenses of this investigation were borne by a grant from the Nutrition Research Laboratories.

[2] D. C. Smith and J. M. Perman, *Endocrinology*, 27: 110, 1940.

[3] I. J. Belasco and J. R. Murlin, *Jour. Nutr.*, 20: 577, 1940.

[4] Supplied by Atlantic Coast Fisheries.

and at the same level of dosage. Over periods of time ranging from 30 to 45 days from the beginning of vitamin administration there was no significant change in the metabolic rate, although there was a tendency to a lower level.

A third series of 6 rats, 4 males and 2 females, was thyroidectomized under ether anesthesia, and after recovery the level of metabolic rate was established. Vitamin A was fed to these animals at the same level as in the previous experiments. There was no significant change in metabolic rates over periods of time ranging from 45 to 60 days from the time vitamin A was started, although again there was some tendency to a lower level.

From these results it appears that the effects of vitamin A on the metabolic rate of rats, even in massive doses, are questionable.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

CONTROL OF BLUE MOLD OF TOBACCO BY A NEW SPRAY

BLUE mold or downy mildew of tobacco (caused by the fungus *Peronospora tabacina*) is one of the most difficult of all fungous diseases to control with fungicidal spray materials. During the five years that mildew has been prevalent in Connecticut the writer has tested many spray materials. None of them have been satisfactory; some failed to stop the disease, some caused plant injury, some were too complicated of preparation and the farmers would not use them.

On the other hand, fumigation of the seed beds with benzol or paradichlorobenzene has given excellent control, if properly manipulated in seed beds which are tightly constructed so that too much of the gas will not leak out during the night. But improper use of either chemical involves certain risks of plant injury. Both are expensive if continued through several weeks.

There exists, therefore, a definite need for a simple, safe, inexpensive but effective spray or dust for controlling mildew in the beds. In quest of such a material the writer has tried a long list of chemicals but only within the last six months has he found one which seems to fill all these requirements. This material is ferric dimethyl dithiocarbamate (under the trade name of "Fermate"). It was first suggested to the writer as a possible mildew remedy by Mr. Harry F. Dietz, of the Grasselli Chemical Department of E. I. du Pont de Nemours and Company, and we are indebted to him for a supply of the chemical and much helpful information on its use.

The first experiments were conducted in the greenhouse during the past winter. All experimental plots were artificially inoculated with spores and, as a result, 100 per cent. of infection on untreated crocks was the rule. Usually 100 per cent. of the unsprayed plants die from the severity of the attack and, therefore, any fungicide which will preserve the treated plants under these conditions must have real merit.

During the winter four crops of plants—eight or ten 10-inch crocks of 200 to 300 plants each—were grown to size suitable for setting in the field and were either kept sprayed during this time with "Fermate" or left unsprayed as checks. The detail of these and later experiments will be published elsewhere.

All unsprayed plants became infected and most of them died. The most successful dosage of "Fermate" was 1½ to 2 grams in a liter of water with the addition of an equal amount of lime. When the plants were sprayed twice a week this treatment gave 95 to 100 per cent. of disease-free plants and they remained healthy until grown to transplanting size. At times there was a small amount of spray injury evidenced by chlorotic areas on the leaves, but this never caused serious detriment to growth and was lacking entirely in most of the trials.

In April of this year the experiments were repeated in the seed beds. The results fully substantiate those in the greenhouse in giving excellent control of mildew.

The results of these experiments, conducted during one winter in the greenhouse and one spring in the seed beds, appear quite encouraging and lead us to believe that we have at last found a successful, simple inexpensive prevention for tobacco mildew. Before drawing final conclusions, however, this treatment should be repeated over several seasons and by practical growers in different sections.

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AN ELECTRIC RECORDING MARKING COUNTER FOR THE CONSECUTIVE COUNTING OF SMALL OBJECTS

A NEW application of an electric counter has been devised for counting the projected cross sections of wool fibers. When magnified 500 times, the average diameter of wool fibers is seldom more than one inch and often is less than 0.5 inch. This counter shows possibilities of further applications in science and in-

dustry where materials of small surface area are to be counted and identified. While elaborate counting procedures involving ruled-glass plates or chambers have been applied on bacteria, blood and particle counts, they are not applicable to fiber counts.

Only recently has projection equipment for enlarging microscopic objects found wide application. Much of the eye fatigue associated with techniques involving direct scrutiny of objects through a microscope is eliminated. The problem of counting the images still remains and while it may be possible to count mentally the number of objects occurring within a projected area, a direct marking counting device may be profitably applied. To fulfil the need for a counter that will mark small objects, an electric recording counter was designed. The marking is accomplished with large soft lead pencil. The motion involved in the marking closes a small switch causing the current to pass through a coil. The magnetic field set-up moves a small laminated steel armature directly connected to an ordinary ratchet counter. A spring assembly quickly returns the counter in readiness for the next count. The counter-actuating assembly may be likened to a small electric motor whose rotary motion is limited to an arc of 45°, just sufficient to bring up the consecutive figures on the counter. A number of ratchet counters are suitable which add one unit for each oscillation of the shaft through approximately 45°. It was found desirable to select a counter without the return spring and supply an adjustable coil spring of greater tension. After experimenting with a number of different solenoids connected by means of a lever system to the counter, the above arrangement, which gives a rotary motion, was considered the best. The laminated core and the high inductance of the field coil makes the use of electric supply from ordinary A.C. line feasible. A three-foot flexible cord is desirable to connect the switch marking assembly with the electrically actuated counter, see Fig. 1.

Fig. 1 is the wiring diagram of the counting assembly. Probably the most vital factor in the proper operating of the counter is the selection of a suitable micro-type switch. There are a number of these switches which are now available on the market. An adjustable metal band holds the pencil in contact with the small plastic pin operating the switch and permits replacement or removal for resharpening. A very slight movement of the pencil causes the circuit to be closed. The silver contacts within the switch permit long continuous operation. It is important to choose a pencil that will mark with slight pressure. The quality of lead should not be any harder than a No. 2. Colored leads or waxes may be substituted for differentiating between materials being counted and for marking various types of surfaces.

Rapid counting and marking of a series of items are possible. It is easy, for example, to count and mark 150 fiber cross sections in one minute. Utilization of the electric counter has greatly speeded up wool fiber analysis by the count method outlined by

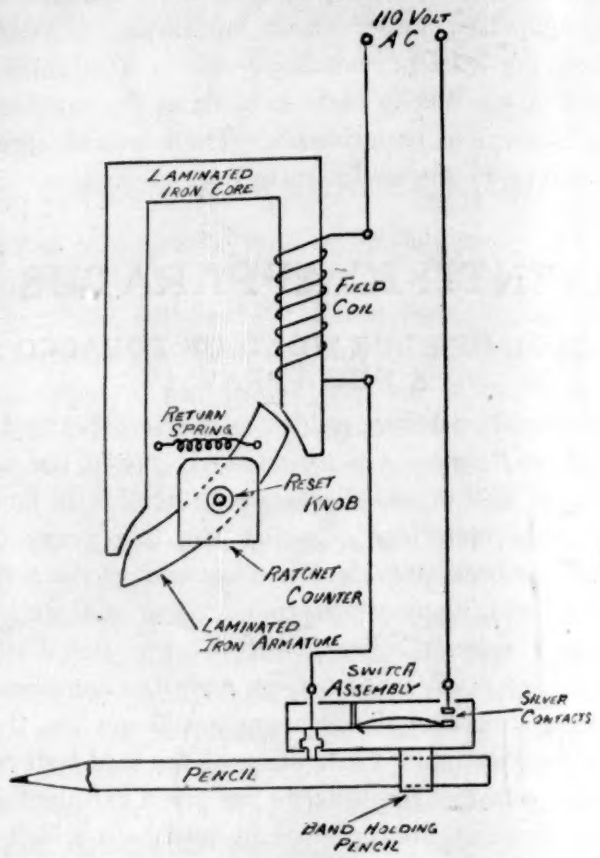

FIG. 1. Wiring diagram for electrical marking counter.

Hardy and Wolf[1]. This method consists in counting the number of wool-fiber cross sections included within a 125-square-centimeter area at a magnification of 500 diameters. Many applications could be mentioned, where advantages are possible by lessening the potential personal errors and speeding up tiresome routine procedures.

H. W. WOLF

[1] J. I. Hardy and H. W. Wolf, U. S. Department of Agriculture Circular 543, 16 pp., illus., 1939.

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